



Fine-Scale Application of the Coupled WRF-CMAQ System to the 2011 DISCOVER-AQ Campaign



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Motivation

Many AQ problems have primary or near-source components

- primary particulate emissions are major contributors to $PM_{2.5}$
- representation of near source gradients
- exposure risk depends on proximity to sources

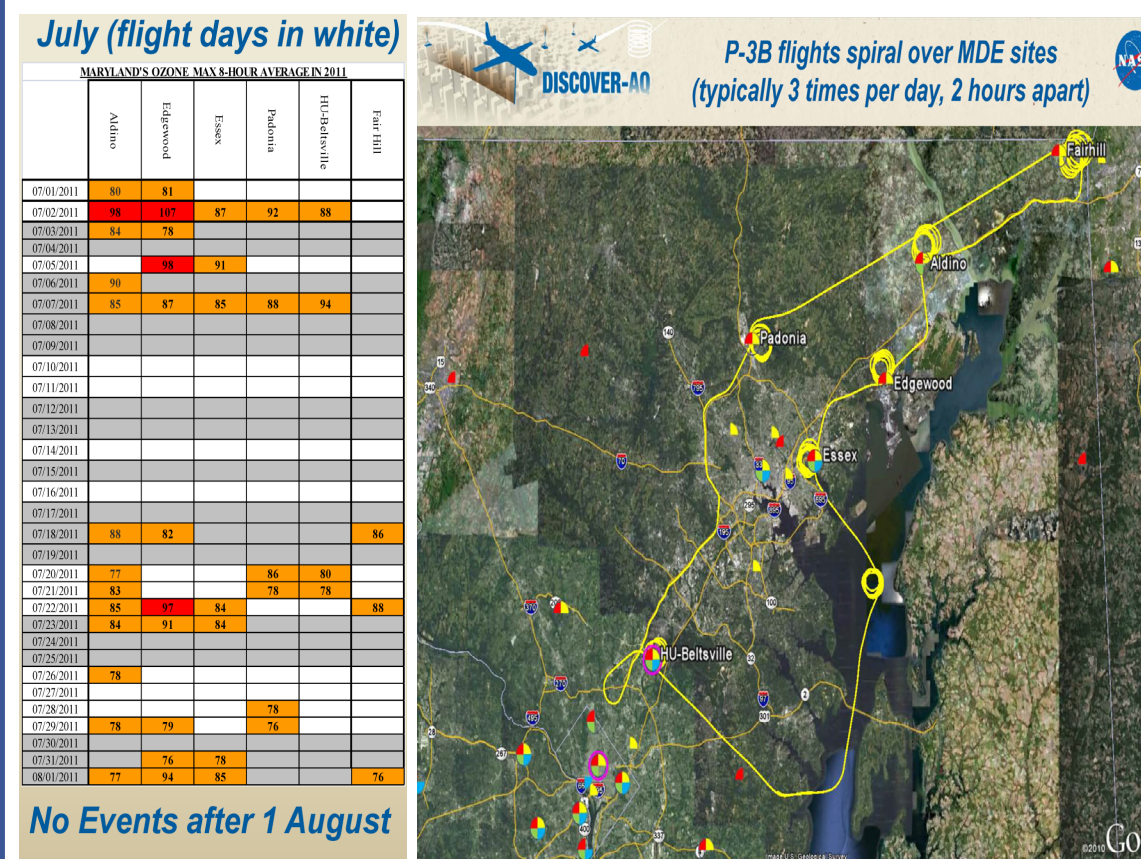
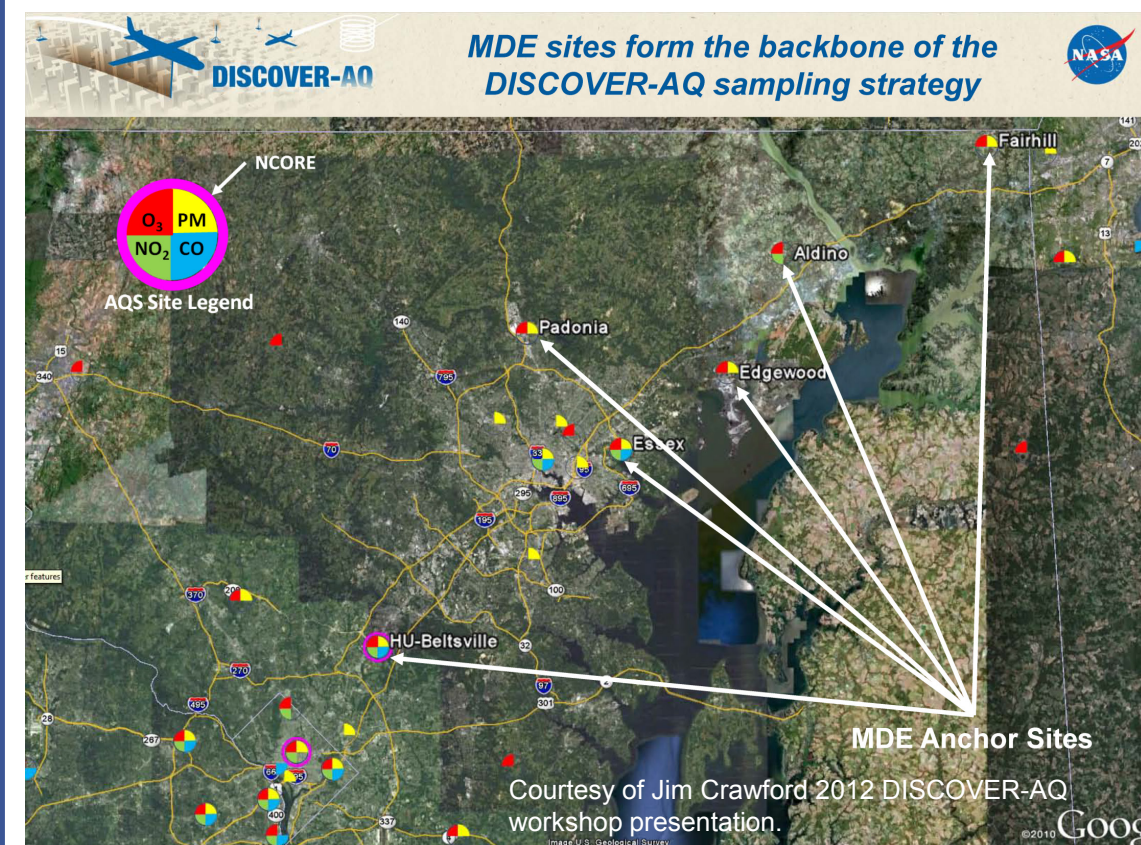
Complex terrain, coastlines and cities require high-resolution modeling to:

- represent local wind fields, PBL structure, etc.
- represent urban effects

Point and line source emission distributions are sub-grid at any scale

- artificial dilution of primary pollutants due to instantaneous mixing of emissions into large grid-volumes
- subsequent impacts on near-source chemistry and predictions of secondary pollutants

DISCOVER-AQ 2011



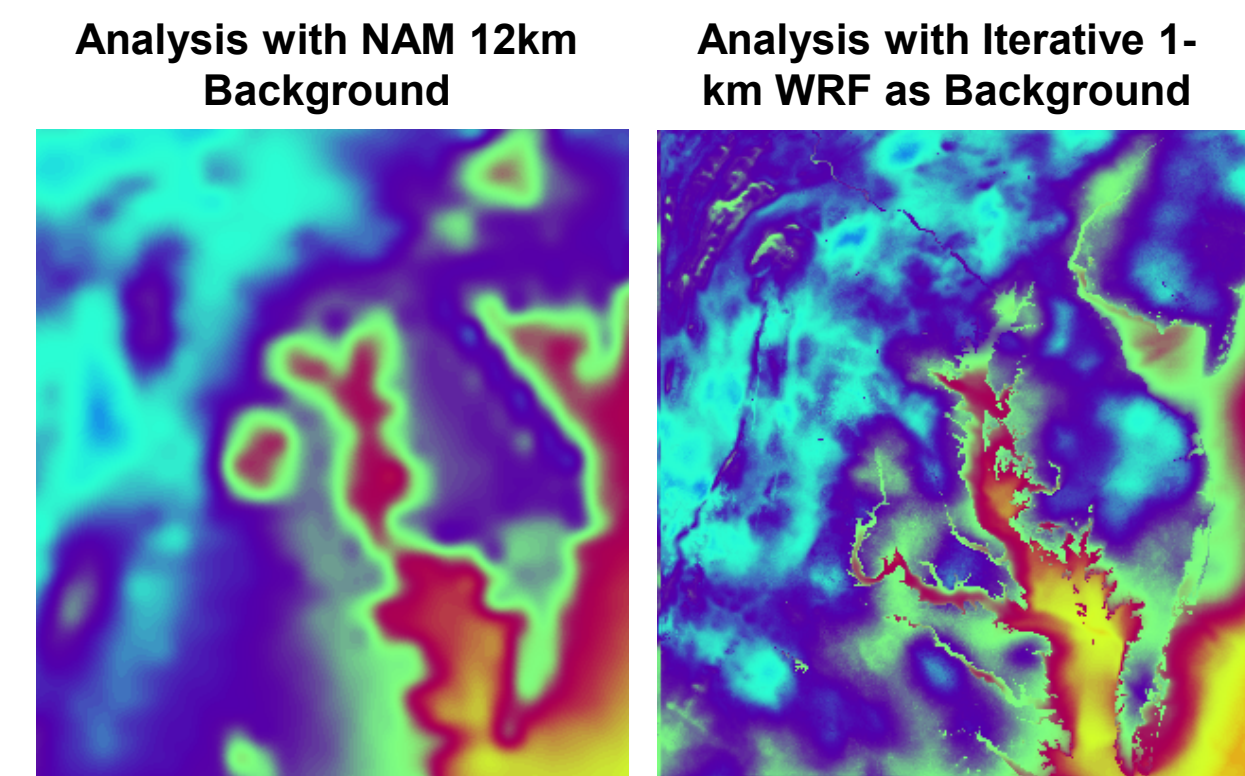
Courtesy of Ken Pickering 2012 DISCOVER-AQ workshop presentation.

Basic problem: data too sparse, especially upper air

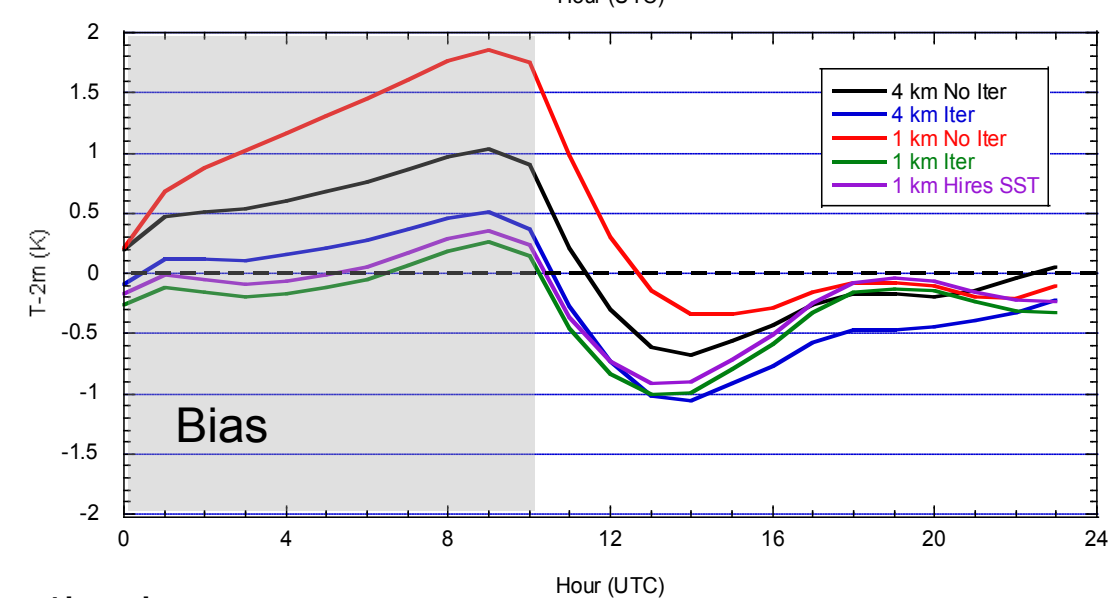
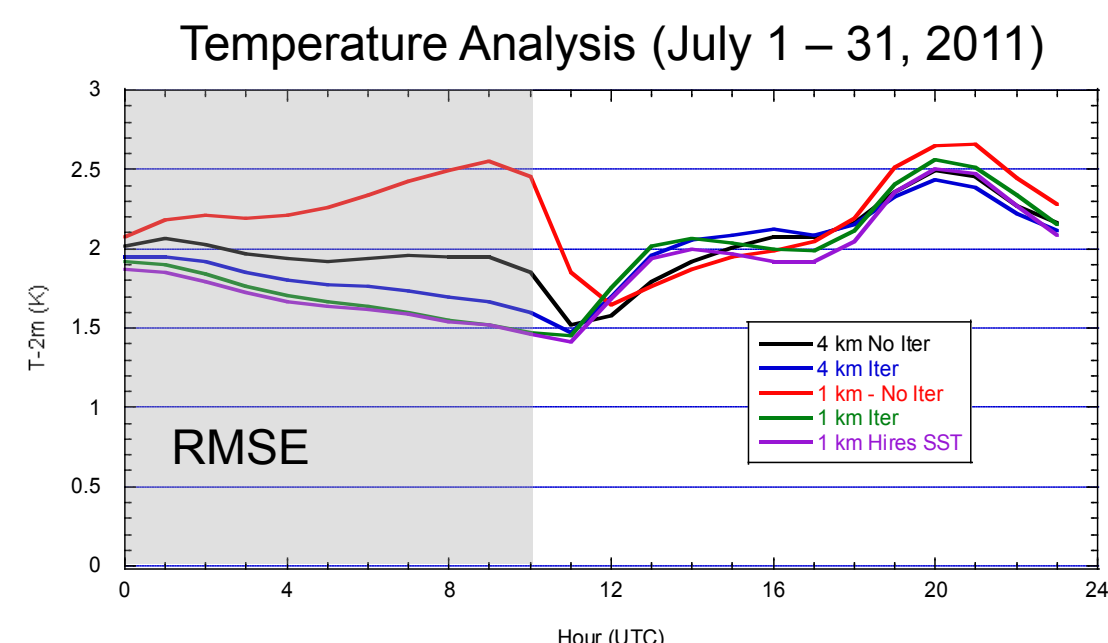
Surface observations are more dense, including mesonets in some areas, but atmospheric nudging in PBL is not desirable

Solution: Assimilate surface and other observation data (precipitation, satellite) into land surface parameters (e.g. soil moisture, soil temperature)

- HRLDAS (Noah LSM)
- Indirect soil nudging (PX LSM)



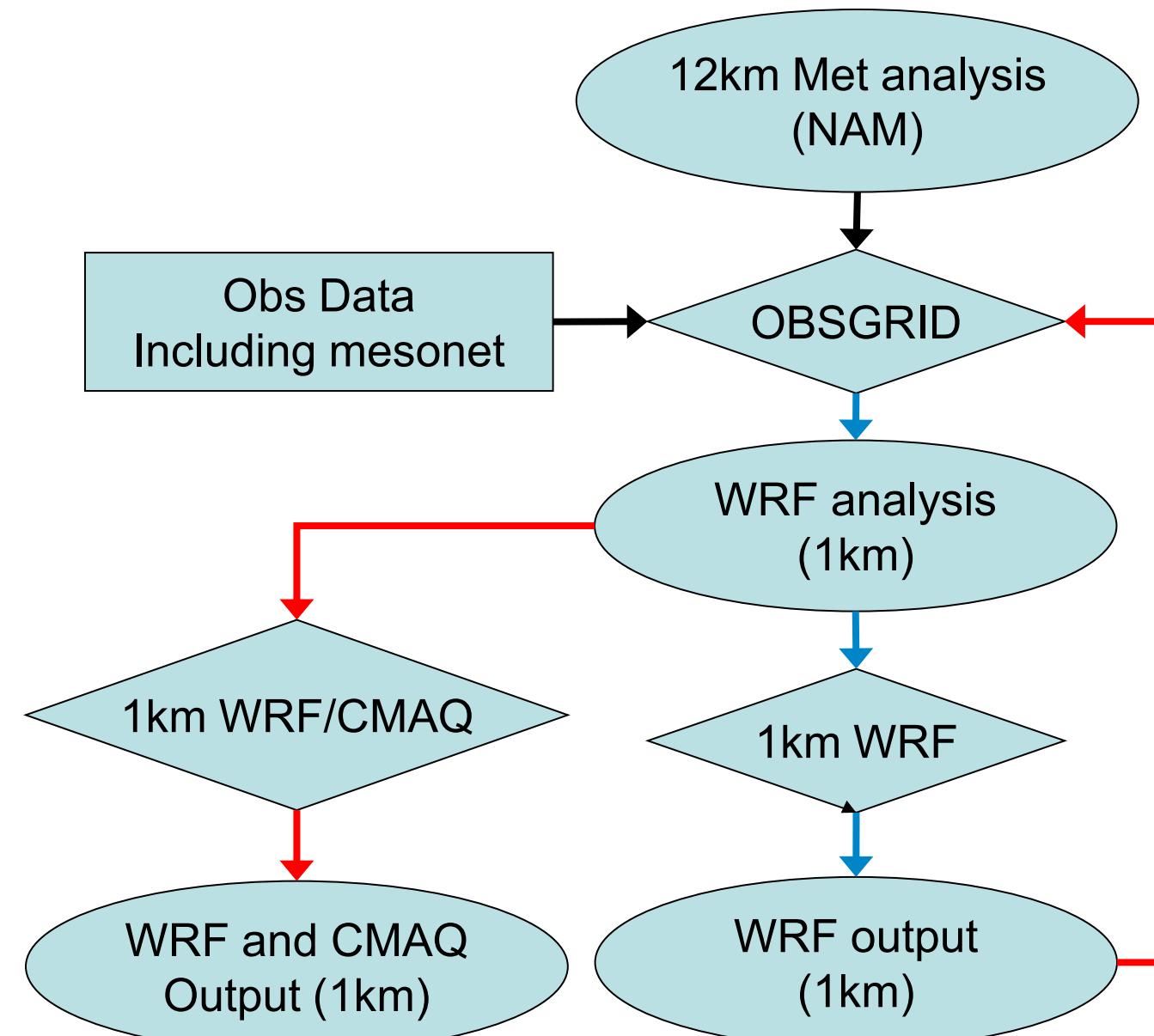
Without sufficient resolution, data assimilation may do more harm than good.



4km base
4-km w/ iterative analysis
1-km base
1-km w/ iterative analysis
1-km w/ hi-res SST (ignore)

Iterative analysis reduces error mostly at night and afternoon with large bias reductions at night

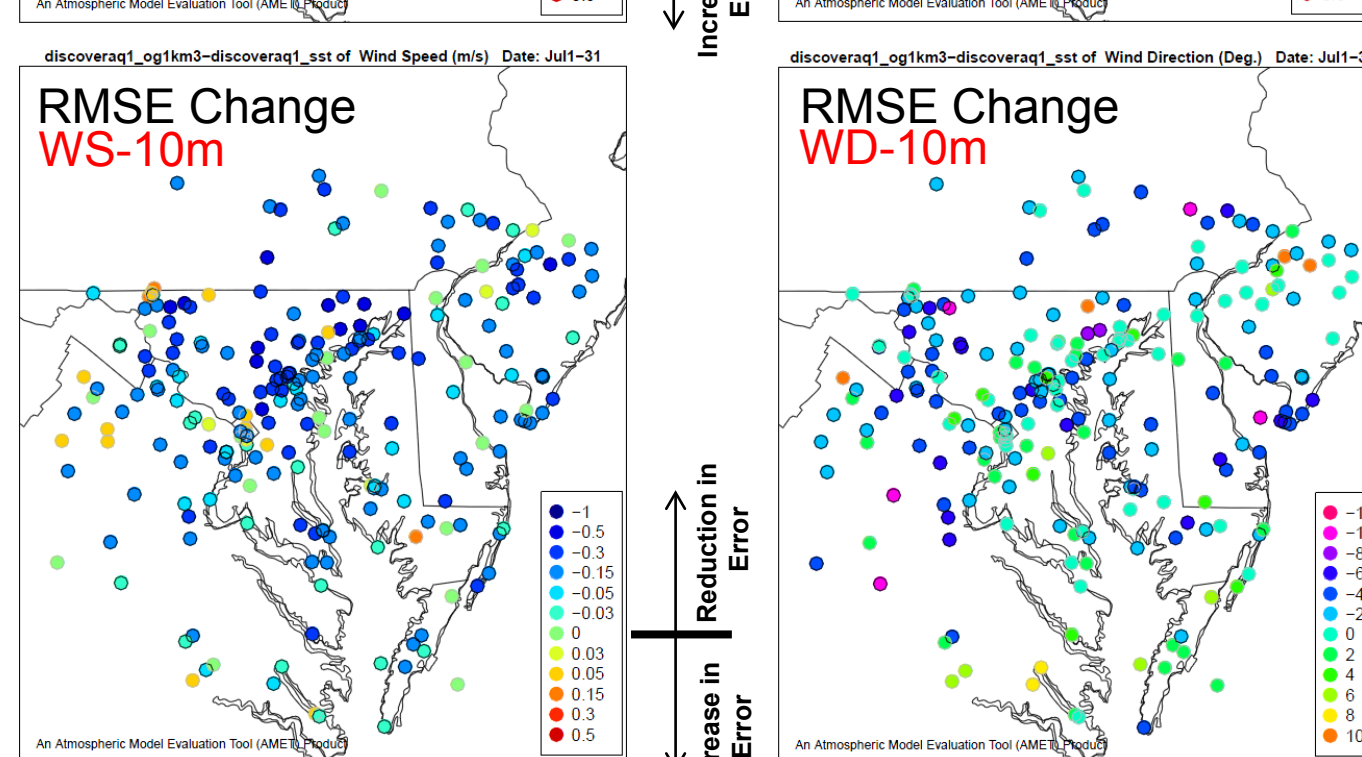
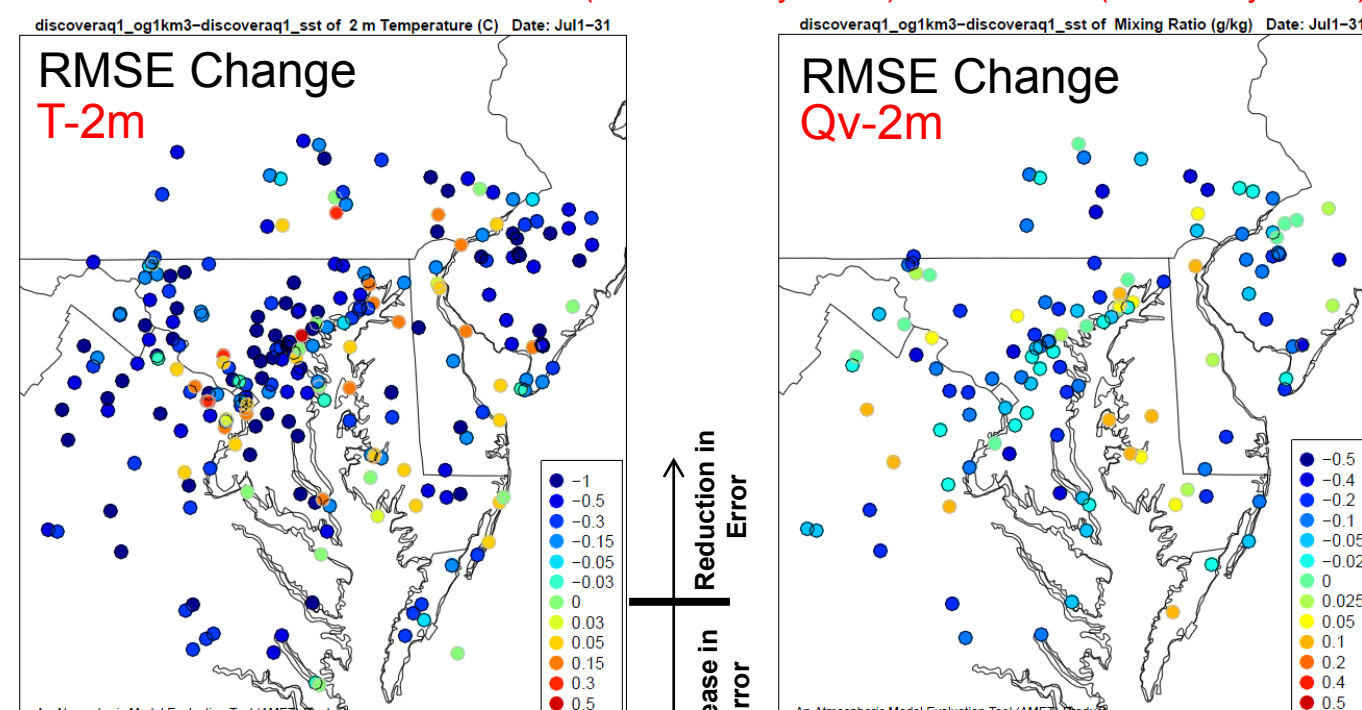
High Resolution Data Assimilation



The PX LSM uses T-2m and RH-2m analyses for indirect soil moisture and deep soil temperature nudging

Initial WRF output is recycled back to OBSGRID as new background (Mesonet adds high density obs data)

RMSE Change = RMSE (iterative analysis run) - RMSE (base analysis run)



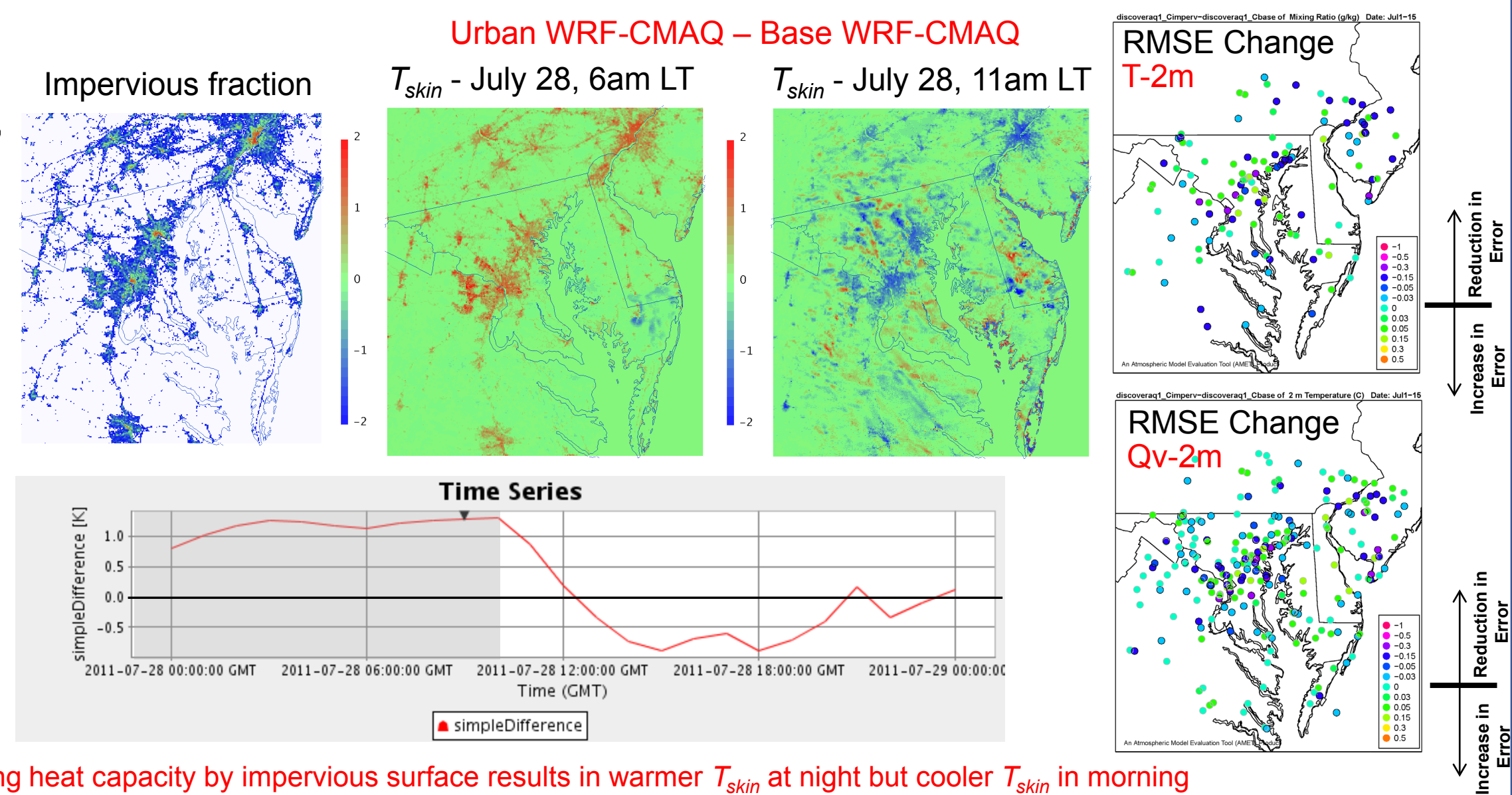
Simple Bulk Urban Approach for Pleim-Xiu LSM

Leverage very high resolution National Land Cover Database (NLCD) with multi-level urban classifications

PX LSM considers sub-grid land use fractions • Utilize NLCD-based impervious surface data directly in LSM to scale surface heat capacity

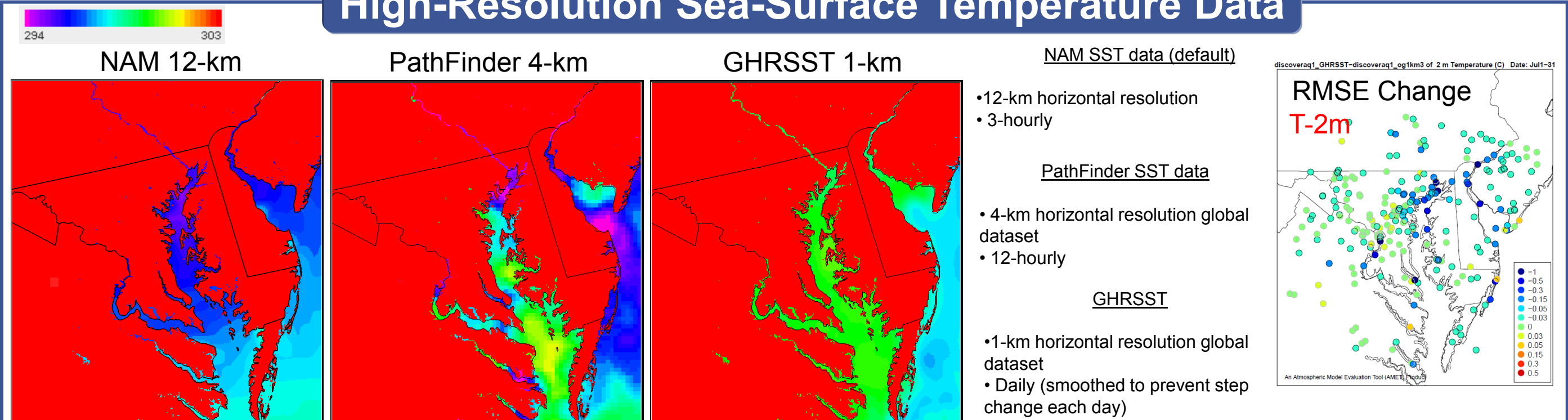
Increase surface roughness for urban land use classes to better represent developed areas

Decrease albedo in urbanized areas to account for sky-view and radiation trapping effects



Scaling heat capacity by impervious surface results in warmer T_{skin} at night but cooler T_{skin} in morning

High-Resolution Sea-Surface Temperature Data



Preliminary WRF-CMAQ Results

